LONGITUDE

To be found out with
A new Invented Inſtrument,
BOTH BY
SEA and LAND.

ALSO,
Some Reaſons for finding it thereby, extracted from the Three Years Obſervations made at *Iſlington* by Dr. *Edmund Halley*, Savilian Profeſſor of *Geometry* in *Oxford*, for knowing the true Place of the Moon, and which now are inſerted in Mr. *Street*'s Caroline Tables.

WITH
A better Method for diſcovering Longitude, than that lately propos'd by Mr. *Whiſton* and Mr. *Ditton*.

Written by R. B. *Secretary to the Honourable Sir* Francis Wheeler, *when Admiral and General in an Expedition to* Martineco.

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BRITISH MUSEUM
30 OCT 61

TO THE READER.

Since an Act of Parliament is paſt for the great Encouragement of that Perſon who ſhall firſt find out the Longitude of Places by Sea or Land, ſeveral Eminent Men excellently Skill'd in the Mathematicks are putting their Wits to work for a Diſcovery of that Secret, which will be highly Beneficial to the whole World. I wiſh, for the good of all Trading Nations, Improvement of Navigation, and abſolute Perfection of Coſmography, *that whoſoever attempts the Invention of* Longitude, *may be ſucceſsful in his Noble Undertaking; but hitherto the Methods propos'd by Mr.* Whiſton, *Mr.* Ditton, *and Mr.* Hobbs, *are far from compleating their Deſign; and if they make no better Offers to the Honourable Commiſſioners appointed by the State for the Diſcovery of* Longitude *than they have hitherto, all Hopes of their diſcovering it may be laid aſide for good and all. The Notions of Mr.* Hobbs *are very abſurd, and the* Lemmata *or Propoſitions of the other Two Gentlemen very inſignificant.*

If what the learned Dr. Brown *ſays in his* Pſeudodoxia Epidemica *be true, it is vain for any Man to ſtrive to find out* Longitude; *his Words are theſe.* “ *There is no* Eaſt *and* Weſt *in Nature, nor are thoſe abſolute and invariable, but reſpective and mutable Points, according unto different Longitudes, or diſtant Parts of Habitation, whereby they ſuffer many and conſiderable Variations. For firſt, unto ſome, the ſame Part will be* Eaſt *or* Weſt *in reſpect of one another; that is, unto ſuch as inhabit the ſame Parallel, or differently dwell from* Eaſt *to* Weſt; *thus as unto* Spain, Italy *lieth* Eaſt, *unto* Italy, Greece, *unto* Greece Perſia, *and unto* Perſia China; *ſo again unto the Country of* China, Perſia *lieth* Weſt, *unto* Perſia Greece, *unto* Greece Italy, *and unto* Italy Spain; *ſo that the ſame Country is ſometimes* Eaſt *and ſometimes* Weſt, *and* Perſia *tho'* Eaſt *unto* Greece, *yet is it* Weſt *unto* China. *Unto other Habitations the ſame Point will be both* Eaſt *and* Weſt, *as unto thoſe that are* Antipodes, *or ſeated in Points of the Globe diametrically oppoſite; ſo the* Americans *are Antipodal unto the* Indians, *and ſome part of* India *is both* Eaſt *and* Weſt *unto* America, *according as it ſhall be regarded from one ſide or the other, to the Right or to the Left; and ſetting out from any middle Point, either by* Eaſt *or* Weſt, *the diſtance unto the Place intended is equal, and in the ſame ſpace of Time in Nature alſo performable. To a Third that have the* Poles *for their* Vertex, *or dwell in the Poſition of a parallel Sphere, there will be neither* Eaſt *nor*

“ Weſt, *at leaſt the greateſt part of the Year; for if*
“ *(as the Name Oriental implyeth) they ſhall account*
“ *that part to be* Eaſt *wherever the Sun ariſeth,*
“ *or that* Weſt *where the Sun is* Occidental *or Setteth,*
“ *almoſt half the Year they have neither the*
“ *one nor the other; for half a Year it is below*
“ *their Horizon, and the other half it is continually*
“ *above it; and circling round about them interſecteth*
“ *not the Horizon, nor leaveth any Part for*
“ *this Compute. And if (which will at firſt ſeem*
“ *very reaſonable) that Part ſhould be termed the*
“ Eaſtern *Point, where the Sun at the* Equinox,
“ *and but once in the Year ariſeth, yet will*
“ *this alſo diſturb the cardinal Accounts, nor will*
“ *it with Propriety admit that Appellation; for*
“ *that ſurely cannot be accounted* Eaſt *which hath*
“ *the* South *on both ſides, which notwithſtanding,*
“ *this Poſition muſt have; for if unto ſuch as*
“ *live under the Pole, that be only* North *which is*
“ *above them, that muſt be* Southerly *which is*
“ *below them, which is all the other Portion of the*
“ *Globe beſide that Part poſſeſſed by them. And*
“ *thus theſe Points of* Eaſt *and* Weſt *being not abſolute*
“ *in any, reſpective in ſome, and not at all*
“ *relating unto others, we cannot hereon eſtabliſh ſo*
“ *general Conſiderations, nor reaſonably erect ſuch*
“ *immutable Aſſertions upon ſo unſtable Foundations.*
“ *Now the Ground that begat or promoted this Conceit,*
“ *was firſt a Miſtake in the apprehenſion of*
“ Eaſt *and* Weſt, *conſidering thereof as of the*
“ North *and* South, *and computing by theſe as*
“ *invariably as by the other; but herein, upon ſecond*
“ *Thoughts, there is a great diſparity; for the*

“ North *and* Southern *Pole, are the invariable*
“ *Terms of that Axis whereon the Heavens do move,*
“ *and are therefore incommunicable and fixed Points*
“ *whereof the one is not apprehenſible in the other;*
“ *but with the* Eaſt *and* Weſt *it is quite otherwiſe,*
“ *for the Revolution of the Orbs being made*
“ *upon the Poles of* North *and* South, *all other*
“ *Points about the Axis are mutable; and whereſoever*
“ *therein the* Eaſt *Point be determined, by*
“ *ſucceſſion of Parts in one Revolution every Point*
“ *becometh the* Eaſt; *and ſo if where the Sun ariſeth,*
“ *that* Part *be termed* Eaſt, *every Habitation*
“ *differing in Longitude, will have this Point*
“ *alſo different, in as much as the Sun ſucceſſively*
“ *ariſeth unto every one.*

Indeed I am not of this Gentleman's Opinion, for certainly the World is diſtinguiſhed by the Eaſt, Weſt, North *and* South *Parts, according to theſe Words of St.* John *the Divine in his* Apocalypſe. I ſaw four Angels ſtand on the Corners of the Earth. And I ſaw another Angel come up from the *Eaſt. Which Text* Napeir *thus paraphraſes,* Afterward I conſider'd, that on all the Four Quarters of the Earth, and I perceived *Eaſterly* toward *Jeruſalem. Therefore I can't be perſuaded, but according to the* Ptolomean *Syſtem, the Terreſtial Globe muſt have Poſitions reſpecting due* North *and* South, Eaſt *and* Weſt; *but was the* Hypotheſis *of* Copernicus *true, which teaches that the Earth turns round, and the Sun ſtands ſtill, why then we muſt grant that there would be no Part of the World fixt to any certain Point of the Compaſs, and thereupon the Marriners*

Needle would be of no Uſe. Though all the Phœnomena*'s of the Heavens are calculated with little Difference by this Syſtem as well as by* Ptolomy*'s, yet is the Aſſertion of the Earth's Motion abominably falſe, as may be prov'd by* Divinity *as well as* Phyſicks; *beſides, I do not know why People ſhould make* Copernicus *the Broacher of this palpable Error, when it firſt ſprung up in the School of* Pythagoras, *who flouriſh'd (according to the Chronological Computation of* Alſtedius) Anno Mundi 3370, *which was 2090 Years before the Time of* Copernicus; *then the ſame Doctrine was cheriſh'd by* Heraclides Ponticus *and* Ecphantus, *two noted* Pythagoreans, *to whom afterwards joyn'd themſelves* Nicetus Syracuſanus *and* Ariſtarchus Samius; *all which have undertaken to defend that the Earth moves circularly, and that this Circumgyration of the Earth cauſes the Riſing and Setting of the Sun, as well as the Moon and Stars. I muſt acknowledge that Dr.* Halley*'s excellent Obſervations on the Variation of the Needle from the* North *is a very good Method for finding out the Longitude, eſpecially in thoſe Parts where that Variation is beſt known; but by the way give me leave to confeſs, that from the curious Obſervations which Dr.* Halley *made at* Iſlington *in the Years 1682, 1683, and 1684, of the true Motion of the Moon, I have ſo well extracted a Method of my own, for finding out the Longitude of Places which I have experienced, both in* Europe, Africk *and* America *heretofore, that I do not doubt of obliging the World ſhortly with a new Inſtrument which ſhall ſhew*

Longitude both by Sea or Land, with the ſame acility and Exactneſs as the Quadrate doth Latitude, when the Sun ſhall ſhine at a certain Hour in that Part of the World, where you ſhall take your Obſervation; and till ſuch an Inſtrument is found out, which any Perſon of the meaneſt Capacity may know the Uſe of in 15 Minutes, if he underſtands but a little Arithmetick, all other ways hitherto invented for this moſt neceſſary Work are uncertain, and muſt be perform'd by ſuch Aſtronomical Methods which is above the reach of every Perſon who is not well Skill'd in the Mathematicks: And as for the other Methods for diſcovering Longitude by the Variation of the Needle, Uſe of Clocks and Watches at Sea, and the Log-Line or dead Reckoning, they are more uncertain and inaccurate. But as for my Method peruſe what follows.

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R. B.

Longitude to be found out with an Inſtrument, by Sea and Land, &c.

OF all the Attempts which have been made hitherto by ingenious Men, for the Invention of Longitude, no Problem hath been more Erroneous and Ridiculous than that of late propos'd by *William Whiſton,* M. A. ſome time Profeſſor of the Mathematicks in the Univerſity of *Cambridge,* and *Humphry Ditton,* Maſter of the new Mathematical-School in *Chriſt*'s Hoſpital, *London.* What Longitude is, *Kepler* tells us in theſe Words; *Eſt arcus æquatoris terreſtris (vel etiam paralleli per locum ducti) interceptus inter primum meridianum terreſtrem & inter meridianum loci, & in conſequentia numeratus.* Epit. aſtron. copernic. lib. 3. Now the finding out of Longitude is to diſcover, as certain a Rule of knowing how far we are diſtant on the Spherical ſurface of the Earth in Degrees and Minutes, from any known Meridian, Eaſtward or Weſtward, as we do for knowing how far we are diſtant in Degrees and Minutes, on the ſame Surface, from the Equinoctial Line, Northward or Southward.

In order to bring ſo neceſſary a Work to Perfection, it is requiſite that all Nations ſhould agree upon one firſt Meridian, or beginning of Longitude, which at preſent is not concluded on; for ſome Coſmographers do make the chief and firſt Meridian paſs through the Iſlands St. *Michael* and of the *Azores*, and there are Two Reaſons why they did there begin to reckon the Longitude of the Earth: Firſt, becauſe at that Time there was no Land known farther to the Weſtward than that Place; and Secondly, becauſe under that Meridian the Needle in the Marriners Compaſs had no Variation, but did point directly *North* and *South*. However, according to *Ptolomy*, that Meridian is ſaid to be firſt and fartheſt Weſtward which paſſes through the *Inſulæ Fortunatæ*, or *Canary* Iſles, as *Maginus* thus tells us in his Geographical Relation thereof, *Autem nominat eas Aproſitum, Heram vel Autolalam, Pluitaliam, Caſperiam, Canariam, & Centuriam; omneſque in rectam fere lineam a ſeptentrione in Meridiem diſponit, unde ſub eodem meridiano cadunt, qui quidem Meridianus initium eſt computationis longitudinis terræ*, Pag. 201. Here it is that famous Geographer fixt firſt his Meridian, for the *Weſt-Indies* were not known nor diſcover'd in his Days, nor of a long time after; ſince when the Diſcovery of *America* being

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ing made by *Americus Veſputius*, *Chriſtopher Columbus*, and others, latter Coſmographers having made the firſt Meridian to paſs through the *Azores*, as above-noted; and which Iſlands, as appears by their Cards, are ſcituated more Weſtward from the foreſaid *Inſulæ Fortunatæ* by 5 Degrees; from this altering the antient placing of the firſt Meridian, they muſt likewiſe alter all the Longitudes ſet down heretofore by *Ptolomy*, or any other antient Writer: Veverthelefs this Matter is eaſily rectified, for by adding to every Longitude Eaſtward 5 Degrees, or by ſubſtracting 5 Degrees from every Longitude Weſtward, you ſhall not greatly vary from thoſe antient Longitudes ſet down by them who reckon'd their firſt Meridian from the *Azores*.

Some endeavour to find out the Longitude of any City, Province, or Place, by the Eclipſes of the Moon; which *Gemma Friſius* thinks to be the moſt exact and abſolute of all other, and thus teaches to be done. Obſerve the beginning of the Eclipſe in that Place whoſe Longitude is unknown, which if it ſhall agree in Hours and Minutes with the time of the beginning of the Eclipſe at *London*, you may be certain that that Place is under the Meridian of *London*, whoſe Longitude is about 20 Degrees; but if the beginning of the Eclipſes differs, then beſure the Miridian and Longitude of that Place differs from the Meridian of *London*, which you may thus find; Subſtract the leſſer Number of the

Hours and Minutes of the beginning of the Eclipſe from the greater, and the difference convert into Degrees and Minutes after this manner: Take for every Hour 15 Degrees, for 4 Minutes 1 Degree, and for every Minute of an Hour 15 Minutes of a Degree; and the Number of Degrees and Minutes ſo found, add to the Degrees and Minutes of the Longitude of the Meridian of *London*, if it be more Oriental (that is, if the Number of Hours ſhall be found greater in the ſame) ſubſtract; if it be more Occidental (that is, if the Number of Hours there be found to be leſs) and you ſhall have the Longitude of the ſaid City which was before unknown. I muſt acknowledge that Longitude may be pretty near found out this way, for being once with Sir *Cloudeſly Shovel*, Admiral of the Red, in *Italy*, and taking an Obſervation at *Venice*, by an Eclipſe of the Moon, I found the Longitude of that Place to be 36 Degrees 12 Minutes, correſpondent to the Longitude given by *Sanſoon*, the *French* Geographer, within 3 Minutes. To this Rule, for the moſt part, are Squared all Coſmographical Tables of Longitude; but yet in this divers Errors do happen, either by the Artificer oftentimes wanting Diligence in obſerving the right Hour and Moment of the Eclipſe, or elſe the divers Epacts and Latitudes of the Moon are commonly neglected; wherefore it is the beſt way, in this Point, that exact Aſtronomers ſhould at divers Places obſerve the ſame Eclipſe,

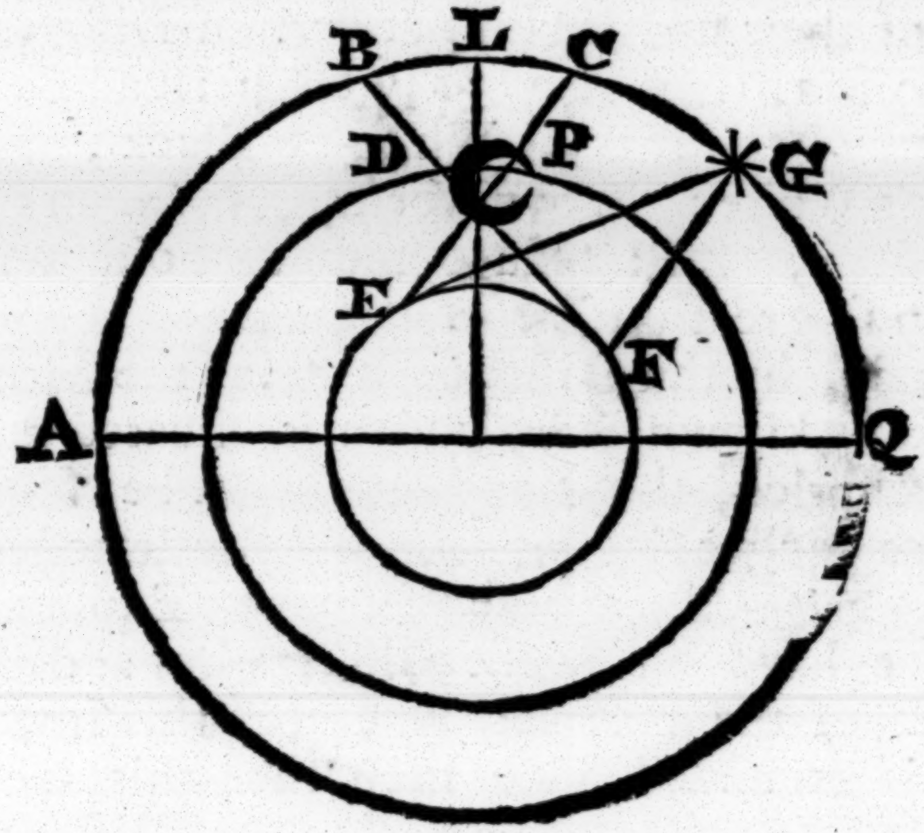
clipſe, and ſo by conferring together, according to this Rule, find out the Longitude of different Places: But exact Aſtronomers cannot be eaſily found in every City or Town whereof we deſire to know the Longitude, and neither is an Eclipſe of the Moon always at command.

Now another Way to find out the Longitude, may be perform'd by a true Horology or Watch, which by an Aſtrolabe is to be rectified, and ſet juſt at ſuch an Hour as you depart from the Place where you are, to go to any other Place, whereof you are deſirous to know the Longitude: In which your going you muſt be diligent to ſee that your Watch never ceaſes going, and being arrived at that Place whereof you ſeek to know the Longitude, you muſt tarry until the Index does juſtly touch the Prick of ſome perfect Hour, and alſo at that inſtant, to ſee what Hour it is by your Aſtrolabe: For if your Aſtrolabe and Watch do both agree in one, then there is no Difference of Longitude, but you have ſtill travelled under one ſame Meridian, either towards the North or South. But if they differ One Hour, or certain Minutes, then reduce them to Degrees, or to Minutes of Degrees, as above taught, and thereby you ſhall find the Longitude deſired to be known. But to take the Longitude upon the Sea by this manner of way, in my Opinion it is better to do it by a great Hour-Glaſs, made to run Twenty Four Hours, which muſt be watched when it is ready to run out, that it may be immediately turn'd: For Watches made of Iron or Steel, will ſoon Ruſt upon the Sea. This way I made an Obſervation (at the Deſire of Admiral *Wheeler*, drown'd near the *Streights*) when I was at *Placentia-Bay* in *Newfoundland*, and found the Experiment true according to the beſt Sea-Charts; however, this way either by Watch or Hour-Glaſs is not always to be depended on, becauſe Watches and Clocks will inequally move, eſpecially on the Sea, and the Sands of an Hour-Glaſs do not always keep the like Motion: Therefore if any Certainty may be this way, it muſt be by the Help of the *Automaton*, or perpetual Motion, of which Invention we may as much doubt, as of Mr. *Whiſton* or Mr. *Ditton* finding out the Longitude by firing Guns or Sky-Rockets.

I muſt acknowledge that by *Trigonometry*, we may, when the Latitudes and Difference of Longitude of Two Places are given, find the Rhumb and Diſtance. When the Latitudes of two Places, and their Diſtances are given, we may find the Rumb, and Difference of Longitude. By the Rumb, and Latitudes of Two Places given, we may find their Diſtance and Difference of Longitude. By the Difference of Longitude, Rumb, and One Latitude, we may find the other Latitude and Diſtance. And by the Rumb, the Diſtance, and One Latitude given, we may find the other Latitude, and the Difference of Longitude,

tude. But for Mr. *Whiſton* and Mr. *Ditton*, to impoſe ſo much upon the World, as to make People believe Longitude is to be Diſcover'd either by Sea or Land, by a Propagation of Sounds, the Noiſe of Cannon, and firing Squibs and Crackers, without taking any Notice of their fixing Hulks at certain Diſtances in the Sea, they may as well perſuade our Country-Men, that White is Black, and Black's White: But never an *Arrian* in this Kingdom, ſhall ſeduce me to hold with him in ſo great an Error.

Again, by the Diſtance betwixt the Moon and ſome known Star, which is ſituated near the Ecliptick, the Longitude may be found out, as taught by *Appian*, and illuſtrated by *Gemma Friſius*, to whoſe manner of Explication, we have for farther Illuſtration added a Figure of the *Parallax*, whereon this Invention is grounded. To ſhew then this Concluſion, we muſt tell you that the Diſtances betwixt the Moon and other Stars in the Firmament, are varied according to the Difference of Places, inſomuch as Two Men living far diſtant in divers Places of the Earth, beholding at one Time the Moon, and ſome known fixt Star, will not find the like Diſtance betwixt them, whereof if a Man doubt, he may be inform'd by this Figure. We will imagine P. to be the Place of the Moon, as ſeated in the lower Orb; G. to be the Place of the fixt Star, whoſe Diſtance from the Moon is inquired; E. and F. Two Stations or Habitations of Men dwelling on the Earth, whereof we may imagine the one to be in *Europe*, the other in *America*; it will be manifeſt that the Inhabitants ſituated in F. will behold the Moon in the Point B. and the fixt Star in G.



becauſe, as the *Opticks* teach us, all Things are ſeen in the Places oppoſite to the Eye, ſo the Diſtance between the Moon and the Star, will be the Arch of the greateſt Circle, B. G. and the Inhabitants ſituated in E. will behold the Moon by the Ray E. C. as likewiſe the fixt Star G. in the Point G. by the Ray E. G; ſo that the Diſtance betwixt the Moon and the fixt Star, will be in that Station the Arch of the Circle C. G. Now by the firſt common Axiom of *Euclid*, that the Arch B.

G.

G. is greater than the Arch C. G. the former being the whole, and the other a Part. Next, out of the ſame Ground, we may as eaſily collect that this Diſtance betwixt the Moon and ſome other known fixt Star is varied proportionally, according to the Diſtances of the Places on the Earth, becauſe ſo many Places as there are, ſo many Diverſities of Aſpects will ariſe, being increaſed or diminiſht, according to the Diſtances of Places on the Terreſtrial Globe: This Concluſion thus demonſtrated, I ſhall proceed to the Practice of it in this manner.

I. It behoves you to ſearch out by the Help of Aſtronomical Tables, the true Motion of the Moon, according to the Longitude, at the Time of your Obſervation at ſome certain Place, for whoſe Meridian the Roots of thoſe Tables are calculated.

II. You muſt know the Degree of Longitude of ſome fixed Star, nigh unto the Eclip-tick, either preceeding or following the Motion of the Moon.

III. You muſt ſeek out the Diſtance of the Motion of the Moon, and the ſaid Star.

IV. The Diſtance once had, apply the Croſs-Staff to your Sight, and ſo move the Croſs to and fro, till you may behold the

Centre of the Moon at the one End, and the fixed Star with the other.

So ſhall you ſee expreſt by the Degrees and Minutes markt on the Staff, the Diſtance of the Moon and the ſaid Star correſpondent to the Place of your Obſervation; which being noted, ſet down alſo the Diſtance betwixt the Moon and the aforeſaid Star which was firſt Calculated. Then Subſtract the leſſer from the greater, the Remainder will ſhew the leaſt Difference, which being Divided by the Motion which the Moon makes in One Hour, you ſhall know the Time in which the Moon is or was joyn'd with the firſt Diſtance of the ſaid Star; then having converted that Time into Degrees and Minutes, the reſt will be perform'd, either by Addition or Subſtraction of the Product thereof to or from that Meridian, for which the Tables whereby you firſt Calculated the Motion of the Moon were appointed and verified. If the Diſtance betwixt the Moon and the fixt Star of your Obſervation be leſſer, then muſt you add the Degrees and Minutes to the known Longitude, ſo ſhall you find the Place of your Obſervation to be more Eaſtward. If it be greater, then Subſtract the Degrees and Minutes from the known Longitude, and the Place of your Obſervation in this Regard will be more Weſtward. The Rules are ſo far true, that the Moon being ſuppos'd to be more Weſtward than the fixt Star, for if otherwiſe your Working muſt be clean contrary; to wit, if the Diſtance betwixt the Moon and the fixed Star be leſſer, you muſt Subſtract the Degrees and Minutes from the known Longitude, ſo ſhall the Place of your Obſervation be more Weſtward; but if it be greater, then muſt you add the Degrees and Minutes unto the known Longitude, and the Place of your Obſervation ſhall be found Eaſtward. This way, though more difficult, may ſeem better than the reſt, becauſe an Eclipſe of the Moon ſeldom happens, and a Watch, Clock, or Hour-glaſs cannot ſo well be preſerv'd, or at leaſt ſo well obſerv'd in a long Voyage; when every Night may ſeem to give Occaſion to this Experiment, if the Air be free from Clouds, and the Moon ſhews her ſelf above the Horizon.

This way of finding out the Longitude I have experienced in the *Mediteranean* Sea, when the late Earl of *Orford* firſt appear'd in thoſe Parts of the World with the grand Fleet of *England*, after obtaining an entire Victory over the *French* at Sea; but beſides, by the Obſervation of the Difference in the Motion of the Sun and Moon, the Longitude of Places may be found out. Now for the performing it hereof by this Rule, you muſt conſider, that we take as granted by all Mathematicians, that the Motion of the Moon is 48 Minutes of an Hour ſlower in 24 Hours, or 360 Degrees, than that of the Sun; that by Obſervation of the Heavens, and other Mathematical Helps, an Artiſt may know in any Place the firſt Meridian, the Hour of the Day, and the Time of the Moon's coming to the Meridian by an *Ephemerides*: Then for Example, ſuppoſe that in *London* the Moon on ſome ſet Day comes to the Meridian at Four of the Clock paſt Noon, and in ſome Part of the *Weſt-Indies* the Moon is obſerv'd to come to the Meridian the ſame Day at Ten Minutes after Four, theſe Grounds thus ſet down, the Diſtance of Longitude at that Place Weſtward from *London* may be in this manner found out by the Golden-Rule. If the Difference of the Sun's and Moon's Motion be 48 Minutes of an Hour in 360 Degrees, what will it be in 10 Minutes? The fourth proportional Number will be 75 Degrees, the Diſtance of Longitude of the Place aſſign'd from *London*, in Weſt Longitude; from which Number the Longitude from *London* being Subſtracted, and the Remainder from 360, the Reſidue will ſhew the Longitude: But Note, that if the Moon in the Place aſſign'd comes ſooner to the Meridian, we muſt count ſo much in Eaſt Longitude.

Indeed there are few Things in Nature, which have more perplext the Wits of ingenious Mathematicians, than the exacteſt way of finding out the Longitude of Places; not that the Matter was over difficult in it ſelf, but that they ſought out a Way to perform this Concluſion, not depending from the Obſervation of the Celeſtial Bodies and Motions;

and alſo it is a Matter never found out as yet; becauſe they propos'd to themſelves one of theſe two Ways to find it out, either by ſome magnetical Inſtrument, or elſe by Induſtry of Navigation, neither of which can much profit. Not the former, becauſe there have never been any fixed Points found in the *Equator* betwixt Eaſt and Weſt, as have been obſerv'd betwixt North and South, ſo that nothing can proceed out of the meer Nature of the earthly Globe, whereon we may ground any difference of Longitude; neither is the ſecond very beneficial, for all Voyages both by Sea and Land are very irregular and uncertain, either by reaſon of ſundry Impediments, as Rocks, Mountains, Woods, contrary Winds, and other Dangers turning aſide the direct Courſe of Paſſengers from any direct Way or Obſervation; or elſe by the Ignorance of Marriners, which ſeldom paſſes ſo far on Diſcovery; and if they do, know not perfectly to delineate out their Journey, as a *Coſmographer* would expect, to any tolerable ſatisfaction.

Herein have we allow'd that at preſent the beſt Ways to find out the Longitudes of Places are by Eclipſes of the Moon, the Motion of the Moon, and by Clocks, Watches, or Hour-Glaſſes; but cannot agree with Mr. *Whiſton* and *Ditton*, that they may be found out by the Eclipſes of *Jupiter*'s Planets, or Satellits, nor by the Log-Line or dead Reckoning; which laſt Way is ſuch an inaccurate Rule, that all Ingenious Men muſt think thoſe Perſons Mad who ſhould offer to propoſe it for a Means to find out Longitude, when by it the beſt Seaman cannot tell in what Latitude he is. But when I ſeriouſly meditate on theſe Two Gentlemens Method of finding out the Longitude by Sounds, it ſeems to me the greateſt Solœciſm in Nature; for as Marriners, to be the better aſſur'd of their Routs and Courſes on the Sea, divide every quarter of the Horizon into Eight ſeveral Winds, ſo that they make the Compaſs to contain 32 Points: Suppoſe then, that a Sound ſhall be made when the Wind is *North-Eaſt*, what Benefit ſhall they receive by it who are *South-Eaſt* and by *South*? It may go towards them that lie *South-Weſt*, and one Point on each ſide of it; but to them in other Points can ſcarce, if at all be heard. Next conſidering the various Poſitions of the Wind, make what Invention they think fitteſt to diffuſe a Sound more horizontally, and how ſuddenly it ſhifts its Corner for ſeveral Points together, what certainty can thoſe that liſten for it have, in order to find out Longitude? Eſpecially ſuch as lie to the Windward of Sounds about the *Caribby* Iſlands in the *Weſt-Indies*, and in other Parts of the *Atlantick* Ocean, where there is a Trade-Wind or conſtant blowing always from one Point with little variation, excepting in or near the Month of *Auguſt*, when theſe Parts are dreadfully afflicted with furious Storms call'd Hurricanes. Alſo Sounds will be of no Effect in thoſe Seas or Parts of the Ocean where Monſoons are uſual, which is a perodical blowing one half Year one way, and the other half Year the contrary; and the Limits of theſe Winds extend almoſt to the Latitude of 30 Degrees on each ſide the Equinoctial Line; beſides the ſhifting of theſe contrary Winds call'd Monſoons, moſtly between the two Tropicks on each ſide the Equator, is not all at once, but ſometimes is attended with Calms and variable Winds, and ſometimes with violent Storms that ſeem to be of the Nature of the *Weſt-Indian* Hurricanes, and theſe Tempeſts or Tornado's are by the Marriners term'd the breaking up of the Monſoons.

Moreover, it it impoſſible to make the Engines which are to make the Sounds, to give all of them Sounds of the ſame Strength, Tenor and Circumſtances, ſo that the Hearers ſhall tell by Ear in what Longitude they be; nor can I conceive how a Sound can move circularly (as Mr. *Whiſton* and Mr. *Ditton* do alledge) unleſs the Wind blows all the Points of the Compaſs at the ſame time the Sound is given. And again, when the Sound is heard, at ſuch and ſuch diſtances, I am ſure they cannot tell no more by the Sound how many Miles off it was made, than they can by it diſcover what Meridian they are under; but could the Hearers by the Sound tell what Meridian they were near, why then I muſt own they could tell the diſtance of that Place from the Place departed; becauſe as *Langius* tells us, *Maximum uſum habet Meridianus in ſupputandis locorum diſtantiis, quæ vel ſola longitudine vel ſola latitudine, vel etiam utraque dimenſione differunt.* Next as *Cluverius* rightly affirms, *Mutabilis dicitur Meridianus, quia ſi tantillum, ortum occaſumve verſus progrediaris, alius continuo erit Meridianus.* It is a Paradox to me how the hearers ſhall know that the interval of apparent Time, in Two Places, where a Sound is excited, and where it is receiv'd, beſides that which is due to the real Propagation of the Sound itſelf, ſhall be the difference of their Meridians, or of their Longitude in Time. Now the Engine or Inſtrument which theſe Gentlemen propoſe to make the Sound with, is a great Gun, in which alſo can be no certainty, becauſe every Gun, tho' of a like Bore, Bigneſs and Metal, will not give the like Sound, neither is Gun-powder of the like Strength; and when theſe two famous Artiſts talk, that Fire or Light 6440 Feet high will be viſible, in the Night-time, when the Air is tolerably clear about 100 Meaſur'd, or 85 Geographical Miles, that is one whole Degree and 25 Minutes of a great Circle, from the Place where it is, even upon the Surface of the Sea; this Aſſertion ſeems to me as if they aim'd to have Beacons placed over the Watry Dominions of *Neptune*, and Warning Guns fixt on all the Mountains adjacent to the liquid Element, that the Spectator and Auditor may both ſee and hear how far he is from

Land. A pretty Projection I vow! As is alſo their fixing Hulls of Ships, without Sails or Rigging at Sea, in all ordinary Caſes, by Anchors; and in extraordinary Caſes, where the Ocean is vaſtly deep, by Weights let down from the Hulls quite thro' the upper Currents into the ſtill Water below, as near as poſſible to the bottom. Indeed to try the Experiment would require a great many Hulls, for multiplying the Periphery or Circumference of the World, which is 21600 Miles, by the Diameter 7200 Miles, the Product is 155520000 Miles, which is the Number of Square Miles on the face of the Terreſtial Globe; then dividing them Square Miles by 7225, the Number of Square Miles in 85 Geographical Miles multiply'd in itſelf, and which is the diſtance they would have theſe Hulls placed from one another; beſides having Maſts erected upon hollow empty Veſſels with White Spheres at their Tops, to be fixt in proper Places, at equal diſtances between theſe Hulls, for the more ſure guiding Ships in Places of Danger, the Product of the aforeſaid Operation in Diviſion is 21525; but allowing one Third of the Globe to be Earth, and ſo dividing the laſt Number by 3, the Product will be 7175, the Number of Hulls to be continually kept in Uſe, and which will not take leſs than (if you allow but Eight Men to a Hull) 57400 Men to look after them.

Truly this is a very whimſical Notion, looking very Ridiculous in Mr. *Ditton* and Mr. *Whiſton*; the firſt of which Gentlemen I do not know, but as for the other, People ſays he is a little beſide himſelf, or rather, if he has any ſuch Thing as Brains, they are really crackt. They might as well have propos'd a Method of building half-way Houſes on the Ocean from *London* to all Places as we Trade to; for ſuppoſe we could raiſe ſo many Men as above-mention'd, how many of them would be willing to lead ſuch deſolate Lives as they muſt on the Sea, in the danger of Drowning and Famine? Even Malefactors would refuſe a Pardon upon Condition of living under ſuch a ſolitary Confinement. But perhaps theſe Gentlemen may ſay that we are not to be at the aforeſaid Charge of keeping ſo many Men and Hulls, but every Nation muſt keep a certain Compliment of theſe Hulls and empty Veſſels with erected Maſts, according to the Extent thereof abutting on the Sea: Why we'll ſuppoſe all this, and what then? As one Nation was at War with another, they would ſpoil theſe Sea-marks; and Pyrates having regard to no Nation, they would deſtroy all of 'em, to ſupply themſelves with Men, as they ſhould have occaſion. Moreover, other ill Conveniencies will accrue to this Project, for in Storms the Cables of thoſe Hulls that lie at Anchor will oftentimes break, and ſuch as are in the Ocean with deep Weights hanging from them into the Water, will drive about with the Wind and ſtrong Currents, were ever ſo many heavy Weights fixt to them; I have ſeen this Experiment try'd in a great Storm once in the Bay of *Biſcay*, and another time in the Gulph of *Florida*, and found this Citation falſe which Mr. *Whiſton* and Mr. *Ditton* quote out of the Philoſophical Tranſactions, That Ships having heavy Weights let down by Ropes from them into the lower Parts of the Waters in the Ocean, when Tempeſtuous, will ride as firmly as if faſten'd by the ſtrongeſt Cable and Anchor to the bottom. And if ſo be theſe Hulls, as I have Remark'd above, lie expos'd to the Caſualties of having the Cables of their Anchors broke, and theſe Hulls which have Weights hanging from them into the Waters of the Ocean, will not remain fixt in Stormy Weather, but drive many Leagues about with the Wind and Currents, I demand which way they'll know how to find their old Stations again, when the Storm is over? Upon my Word this New Method of finding out the Longitude of Places is very inſignificant, and if (as they ſay) in caſe ſome Parts of the Ocean prove ſo very deep and rough that no Hulls can be fixt in them, the way to recover the Longitude, which may be by this means interrupted, is rightly propos'd by Sir *Iſaac Newton* himſelf, in his Paper deliver'd in to the Houſe of Commons, declaring that upon ſuch Accidents, they muſt Sail obliquely from the laſt Hull into the Parallel of the next, and ſo all along the ſame till upon approaching to that next Hull the Longitude be a-new recover'd, and the Voyage be continu'd as before. Let me ask, may none of theſe Hulls be loſt in bad Weather? And if ſo, what Courſe muſt the Ship then Sail that is to be guided by ſuch a Mark at Sea? Again, is it to be ſuppos'd that Ships ſetting out from *London*, *Briſtol*, *Leith*, or any other Part of *Great-Britain*, will Sail out of their way to be guided by theſe Hulls and empty Veſſels, which may lie many Leagues to the Windward or Leeward of them? No, they will make the beſt of their way; and tho' they may get Men to ſupply theſe Hulls in hot Climates, I queſtion whether any will be ſo mad as to look after them about *Baffin's-Bay*, *Groenland*, *Button's-Bay*, *Greenland*, *Scythick* Ocean, *Tartarian* Sea, and the *Streights* of *Magellan*; where they muſt moſt part of the Year encounter with more than *Cimmerian* Darkneſs, deſtructive Cold, Mountains of Snow, and Rocks of Ice; in the midſt of theſe Extremities the exploſions of Guns, firing combuſtible Matter in the Air, and other Signals would be wholly laid aſide.

As for the Method which Mr. *Hobbs* propoſes for finding out of the Longitude, I ſhall not deſcant on that, becauſe it is as uſeleſs as the other: I ſhall now proceed to declare, that the Rules which I have before allow'd for the finding out the Longitude of Places are the beſt hitherto known; but as the certainty is not infallible, give me leave to ſay farther, that the Longitude is never to be exactly found out till an Inſtrument is made for that Purpoſe, which ſhall ſhew the Longitude of any Place, when the Sun ſhines, with as much exactneſs as the Quadrate diſcovers the Latitude. Such an one I hope ſhortly to bring to Perfection, fixing the firſt Meridian at *Weſtminſter-Abby*, and allowing for every Degree of Longitude on each ſide the Equinoctial Line, the Number of Miles and Minutes ſet down in the following Table.

Degrees.	*Miles.*	*Parts.*	*Degrees.*	*Miles.*	*Parts.*
1	59	59	18	57	4
2	59	58	19	56	44
3	59	55	20	56	23
4	59	51	21	56	1
5	59	46	22	55	38
6	59	40	23	55	14
7	59	33	24	54	49
8	59	25	25	54	23
9	59	16	26	53	6
10	59	5	27	53	28
11	58	54	28	52	59
12	58	41	29	52	29
13	58	2	30	51	58
14	58	13	31	51	26
15	57	57	32	50	53
16	57	41	33	50	19
17	57	23	34	49	45

Degrees.

Degrees	*Miles.*	*Parts.*	*Degrees.*	*Miles.*	*Parts.*
35	49	9	63	27	14
36	48	32	64	26	18
37	47	55	65	25	21
38	47	17	66	24	24
39	46	38	67	23	27
40	45	58	68	22	29
41	45	17	69	21	30
42	44	35	70	20	31
43	43	53	71	19	32
44	43	10	72	18	32
45	42	26	73	17	33
46	41	41	74	16	32
47	40	55	75	15	32
48	40	9	76	14	31
49	39	22	77	13	30
50	38	34	78	12	28
51	37	46	79	11	27
52	36	56	80	10	25
53	36	7	81	9	23
54	35	6	82	8	21
55	34	25	83	7	19
56	33	33	84	6	16
57	32	41	85	5	14
58	31	48	86	4	11
59	30	54	87	3	8
60	30	0	88	2	5
61	29	5	89	1	3
62	28	10	90	0	0

Note, that in the firſt Column you have the Number of Degrees, to the uttermoſt Extent of the Northern or Southern Pole on either ſide the *Equator*; the ſecond Column ſhews the Number of Miles contain'd in each of the 90 Degrees upwards or downwards; and the third the Parts of a Mile; and the ſame Table ſerves to ſhew howmany Minutes and Seconds are requiſite to make one Degree of the Equinoctial, by ſuppoſing the ſecond Column to be Degrees inſtead of Miles, and the third Column Seconds inſtead of Parts of a Mile. 'Tis true, there is a great Difference among Authors concerning the Circuit of the whole Earth, for *Strabo* and *Hipparchus* compute it at 31500 Miles; *Eratoſthenes* at 31250 Miles; *Poſſidonius* and the antient *Arabians* at 30000 Miles; *Ptolomy* at 22500 Miles; and the latter *Arabians* at 25500 Miles: But I follow the *Italians* and *Germans*, who reckon the Earth to be 21600 Miles in Circumference; and having no leiſure now to enquire into the Reaſons, for theſe great *Mathematicians* ſo widely diſagreeing in their Menſuration of the Earth, I ſhall only add, that the Inſtrument which I ſhall propoſe for finding out of the Longitude of Places, will likewiſe ſhew the Elevation of the Pole in any Degree of Latitude North or South, the Bearings of one Place from another, and the exact Hour of the Day either by Sea or Land; but in the mean time, my Reader muſt Pardon me, for not deſcribing by a Figure the Form thereof, and in what manner I ſhall make my Projection good, ſince ſuch a Diſcovery would ſet others to try the Experiment; therefore the World muſt have a little Patience, for ſince I have ſpent a great deal of Pains and Time, without taking any notice of Charges, in the Invention of this Inſtrument, it is but reaſonable that the Inventor ſhould have the Encouragement to be given, in caſe it anſwers what he propoſes.

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